Moreover, the very concept of a controlled area implies that access is *"controlled"* and that the general public cannot gain access to such areas. Furthermore, a infant with its mother can be 'transient' for many hours waiting in an airport, at a bus stop, at a train station, sitting in a shopping center, or walking on the sidewalk in a residential area, park, or beach. If a transmitter may put out high amounts of irradiation then the area affected should be fenced off, the transmitter can be higher so that ground level exposures are lower, or the transmitter should be moved to another location.

Thus, the wording of 13.1 above is contrary to sound reasoning, the directives of the federal health agencies, the Commission's own decisions and policies, and contrary to the public interest. Rather the Commission should adopt the approach of 17.4.3 and let time averaging be responsive to very short temporary exposures.

Moreover, if very short averaging times are adopted by the Commission as requested by the Ad-Hoc Association, this would rightfully acknowledge that such 'very short' and 'temporary' relatively high exposures may indeed pose a risk and should not be permitted. In such cases, the location of base station transmitters would rightly need to be more carefully selected, and fencing or other barriers placed to assure that children or others do not receive high exposures.

14. Summary of some key Ad-Hoc Association FCC 96-326 Petition requests are already addressed in the Nuclear Regulatory Commission ("NRC") Code of Federal Regulations. In the Ad-Hoc Association June 10 submission support for Ad-Hoc Association requests included noting precedents in the NRC regulations. For the convenience of the Commission a summary of those NRC regulations are given below.

Ad-Hoc Association request

(i) Exposure is kept as low as reasonably achievable (ALARA) [Ad-Hoc Association FCC 96-326 Petition at page 18 which states to add a Note 3 to Table 1 of 47 CFR §1.1310 which states, *"The limits in this table are to be treated as maximally tolerable limits, and that in view of our limited knowledge on the thresholds for all biological effects, exposures should be kept as low as reasonably achievable (ALARA)."*

NRC: 10 CFR §20.1101(b): *"The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA)."*

Comment: Given the above, the Ad-Hoc Association requests the Commission state,

"Decisions on the placement, construction, modification, and operation (including use of procedures and engineering controls) of Commission licensed facilities, shall, to the extent practicable, be based upon sound radio-frequency irradiation protection principles to achieve occupational irradiation exposures and irradiation exposures to members of the public that are as low as reasonably achievable (ALARA)."

(ii) Require the elements of a RF health and safety program be implemented
Ad-hoc Association request:

NRC: 10 CFR §20.1101: *"(a) Each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part (See §10 CFR 20.2102 for record keeping requirements)."*
and 10 CFR §20.1101 (b) [see (i) above]

(iii) No 'grandfathering'

All base station facilities currently licensed as well as those applying for a new or renewal license should be meeting the criteria to be applied to new applications for a license, and all portable or mobile phones, including those already authorized should be expected to meet the criteria applicable to new applications for authorization to use portable or mobile phones

The Commission should establish the same rules concerning exposure limits for electromagnetic radiation as has the Nuclear Regulatory Commission ("NRC"). These rules state:

- NRC: 10 CFR §20.1008(b) (1996): *"If the requirements of this part* (the new rules) *are more restrictive that the existing license condition, then the licensee shall comply with this part unless exempted by paragraph (d) of this section."*

10 CFR §20.1008(d) (1996) provides,

"If a license condition or technical specification exempted a licensee from a requirement in the standards for protection against radiation in effect prior to (date new rules went into effect), it continues to exempt a licensee from the corresponding provision of (the new rules)."

Note that since new limits are established and the previous limits of the Commission are now only allowed to apply to workers under certain conditions, following the NRC approach all FCC stations would need to be in compliance with the new limits which will also apply to new applicants or renewal applicants.

- 'no grandfathering' means that whatever RF exposure standard the Commission will apply to new applications for a license the Commission will apply the same criteria to all presently licensed facilities, and thus including license renewal applications.

- the Commission overlooked or misunderstood what was in the public interest, and overlooked or misunderstood its own decisions and rules when it stated,

(limited grandfathering to renewal is ok).

This is because the Commission has also stated,

- *"The exposure limits in §1.1310 are generally applicable to all facilities, operations and transmitters regulated by the Commission."* [47 CFR §1.1307(b)(1)]

- "The Commission expects all its licensees to comply with the RF guidelines specified in our rules ...." [FCC 96-326, para. 160]

- *"We believe the rules we are adopting should provide a reasonable transition period for applicants and stations to come into compliance with the new requirements."* [FCC 96-326, para 112, with the transition period being the same date for all licensees, except amateur radio operators]

Yet, in its rule the Commission appears to issue contradictory decisions. For, in spite of the above which clearly specifies that all stations, and not just new and renewal applicants, are to be subject to the new limits, yet the Commission states,

- *"With respect to previously-licensed stations, we note that we expect our licensees to comply with our RF radiation environmental rules as applicable to them....Once a license is granted, we expect our licensees to continue to operate their facilities in compliance with these limits."* [FCC 96-326, para. 119]

- *"After considering the comments and the impact of these new requirements, we conclude that the new RF guidelines will apply to station applications filed after January 1, 1997.* [FCC 96-326, para. 112]

The Commission is unclear in the above statement, and some parties may imply it means that the rules will only apply to station applications but not to existing approved licensees. Accordingly, the Commission must clearly state its correct policy given in 47 CFR §1.1307(b)(1) above, that all licensees, existing, new and renewal applicants, shall at the same time, after the transition period date, be subject to the new requirements.

The need for such a requirement is, in part, based upon the reasons given in the Ad-Hoc June 10 submission at pages 46-48 where it is shown that the previous Commission rules are found inadequate and which contain "unacceptable" risks to worker health and safety. Also, given the adverse effects provided in this proceeding by the Ad-Hoc Association and other parties, to allow the public to be exposed to 5 fold higher exposures would not be in accordance with the Commission's responsibilities to act with caution to protect the public health and public interest.

Moreover, since both the IEEE C95.1-1991 and NCRP 1986 RF standards acknowledge a paucity of studies of effects due to chronic exposure to low levels, and since the Ad-Hoc Association and others have provided evidence of adverse effects at very low RF exposure levels and evidence of biological effects which have important roles in critical body functions, there are grounds for finding that even the new limits of the Commission are not adequate and will need to be made more stringent. Given this, the Commission may have overlooked or misunderstood that it cannot show prudence and caution and still now stipulate a policy that its licensees need only meet the requirements in effect when a license is granted (as it appears to do in FCC 96-326, para. 119 above.) - since there is strong evidence that to protect the public health these limits may need to be made more stringent. Therefore, the Commission should rephrase its statements and make clear that all its licensees must comply with its new limits.

In particular, the last sentence in FCC 96-326 para. 119 should be changed to read,

"Once a license is granted, we expect our licensees to continue to operate their facilities in compliance with these limits, unless the Commission shall establish more stringent limits, in which case all licensees should expect to follow these new limits."

(iv) Record keeping: As has been shown in these proceedings, there may be significant adverse effect to workers and to the general public from non-ionizing RF irradiation. Yet the Commission has stated, *"The Commission has no specific recordkeeping requirements related to compliance with the RF exposure guidelines."*[131]

Yet, the Commission should not be any less diligent, cautious or protective of worker safety and the public safety and welfare than the NRC insofar as requiring accurate and well documented records is concerned, for the keeping of accurate records of exposure and records of

documentation of the implementation of a worker RF safety program is a critical element of any such RF safety program and program to protect the public safety.

Therefore, the Commission should establish rules for record keeping which would be similar to those of Subpart I -Records (10 CFR 20.2101-10 CFR 20.2110) of the NRC.

Therefore, just as the Nuclear Regulatory Commission is not primarily a health agency but has a different mission of providing electric power and other uses from ionizing radiation, so too the Commission is in a similar role and can appropriately and with proper jurisdiction apply protections in a similar manner as the NRC regulations.

15. The Commission should not permit exposures above what would be traditional protection limits to prevent the biological effects observed and reported herein and in this proceeding on the head and brains of laboratory animals and nerve tissue in culture (as with the studies of Wachtel above). But if nevertheless, the Commission will permit such exposures, then warning messages should appear in all advertisements, on the product, and packaging; likewise for studies showing pathological changes to the blood brain barrier. For workers the Commission should require that the RF health and safety program in effect will shield the heads of workers from any higher exposure. The philosophy that justifies warnings on pharmaceutical products also applies to both mobile phones and to persons living near base stations and where there are exposure levels that would exceed traditional protection limits set to 1/100th the threshold level at which an adverse effect or an effect unwanted by the population is to be avoided.0

16. The Commission should not be swayed from considering the studies reported by the Ad-Hoc Association because they have not been sufficiently replicated to meet the requirements of some parties; prudence requires consideration of these studies, and also existing standards have not required such replication for the studies they have used to set limits. Please see above comments of Granger Morgan and the panelists of panel #6 of the 1993 EPA radiation conference noted above.

17. No allowance for duty factors should be allowed when determining exposure levels allowed for workers [per FCC 96-326 para. #74], but rather continuous exposure should be assumed. This is because the Commission has not provided for any RF program as requested and described

above. Also, there is no good reason to assume the practical existence of a well designed program assuring training would be sufficient that duty factor times would be strictly observed . Moreover, even if there were such a program, the Ad-Hoc Association and other parties have shown that the studies of Wachtel and the observed occupational accidents (within the Commission's 'safe' limits) provide evidence that adverse effects can occur in a mere few seconds. Thus, allowing higher exposures that are later "averaged out" over a 6 minute or 30 minute period have been shown by actual events not to be scientifically valid.

18. The Commission has erred in not requiring re-authorization and testing of previously approved hand-held devices [as it decided in FCC 96-326 para #118], and has overlooked or misunderstood the evidence presented that many of such devices do not meet the Commission's new exposure limits, and also do not meet the more stringent limits requested by the Ad-Hoc Association in this proceeding based on evidence in the record. Recalls have been made on many other products and is feasible in this case. The evidence for adverse effects at even lower limits allowed by the Commission indicate that to allow devices that would even exceed these higher limits to remain in use is not prudent or in the public interest.

19. Based upon the rationale for the Commission's exposure limits for hand-held devices, the requested decrease in the Commission's hazard threshold to 15% of its present value should result in a proportional reduction in the Commission's power density exposure criteria for general population/uncontrolled and occupational/controlled settings, and also applies to the localized body specific absorption rate (SAR), such as pertains to the head.

Therefore, since the Ad-Hoc Association has presented considerable evidence that the Commission's hazard threshold based on the criteria of disruption of behavior should be no more than 0.6 W/kg, it follows that a 'safe' limit using the rationale of NCRP 1986 will be 0.6/50 = 0.012 W/kg. Hence, an SAR of 20 fold this average allowed in a localized region would be 0.24 W/kg. It should be noted that the Commission cites studies indicating it was feasible for mobile handsets to achieve this limit[28]. It should be noted that other results in this proceeding also support these low limits.

It should be noted that a threshold was not observed at this level, and consequently the limit should be even lower.

20. Moreover, in addition to #18, the Commission should base its criteria of exposure allowed to the head according to the SAR values in the head at which a disruption of behavior occurred; this is known for rats[31]. This is relevant to the experiments of H. Lai et al (1989, 1994) since it was demonstrated that behavior changes were due to factors occurring in the brain of the rat, and could be blocked by affecting receptors in the brain[29,30].[see Ad-Hoc Association FCC 96-326 Petition at page 16].

While there may not be conclusive proof that a SAR level in the brain is associated with a disruption of behavior, nevertheless there is some evidence this is so, and it is a prudent and reasonable assumption. For evidence consider, the study of Frey (1967). He reports that at an average power density of 30 microwatts / sq. cm. in the frequency range of 1200 to 1525 MHz that. there was an RF effect on the evoked potentials in the brain stem of cats. However, *"Illumination of the body when the head was shielded resulted in no effect."* This is strong evidence, that whatever is causing the effect has no relationship to average whole body SAR, but only on the direct illumination of the head.

Consider that at an average SAR of 0.6 W/kg there was disruption of learning behavior[29,30]. For this exposure, experiment found that the SAR in the parts of the brain varied from 0.5 to 2[31] W/kg. Applying the 50 fold 'safety factor' of both NCRP and IEEE, 2 W/kg /50 = 0.04 W/kg.

Information is also known for far field exposures[31], and a similar method could apply there for determining the SARs at which disruptions of behavior occurred when the whole-body average SAR was 0.7 W/kg[32,33]. D'Andrea et al (1986)[33] report an average whole body SAR of 0.7 W/kg when the far field incident power density was 2.5 mW/sq. cm. Using Chou et al (1984)[31] this also yields a similar maximum of about 2 W/kg in the brain areas measured, and applying the same safety factor used in NCRP 1986 a limit of 2/50 = 0.04 W/kg is found, and is a reasonable value from the point of view of being prudent about safety. Insofar as the Ad-Hoc

Association is not expert in these matters, as with other health claims and concerns in this proceeding, the Commission is urged to seek the evaluation of the federal health agencies.

This approach is more reasonable than the current approach. The current approach makes note that for some frequencies and for some exposure conditions some parts of the body can have 20 fold greater SAR than the average. For example, for some frequencies the legs often have the greatest SAR[34]. The standard then makes a 'jump' and assumes that a whatever average SAR is selected to be the hazard threshold that it is safe for any part of the body to be exposed to 20 fold the average SAR. This does not logically follow. Since the distribution of SAR in the head of both rats31 and monkeys has been studied, one should be able to determine what the SARs were in the head when disruption of behavior occurred. This is certainly more prudent than assuming that the SAR in a leg or neck is safe for an SAR in certain parts of the head.

If Commission will allow more exposure to the head than considered prudent by the Ad-Hoc Association, then the Commission must assure that there is an RF safety program in affect as above that using head protection materials or other means limit internal exposure to the head to that requested by the Ad-Hoc Association.

21. The Commission should consider the recommendations of David Fichtenberg submitted as "Response to Notice of Public Information Collection Being Reviewed by the Federal Communications Commission" dated October 15, 1996, and use the suggestions there, or by other means, to provide a data base that is publicly available accessible as at present, and to view a data base of each Commission licensed transmitter and its estimated impact on power density.

22. Using satellite and 20 mile high altitude remotely piloted solar powered airships, telecommunications signal systems may be feasible and result in far less exposure than ground based systems. Possible receive only antennas on the ground may further limit power requirements to send signals.

23. Corrections to the ex parte submission of the Ad-Hoc Association dated June 10, 1997.

23.1 Footnote 53 should be: EPA, "The Radiofrequency Radiation Environment: Environmental Exposure Levels and RF Radiation Emitting Sources," EPA 520/1-85-014, July 1986

23.2 Footnote 128 of Ad-Hoc Association FCC 96-326 petition should be footnote 141 below.

23.3 The 11th line on page 14 of the Ad-Hoc Association FCC 96-326 petition is a typographical error (e.g. line beginning with "2. Avg SAR of 1 year old ....") and should not be there..

24. The Commission's power density limits are not correctly linked to SAR and do not apply the recent science findings

The purpose of the following is to review the evidence provided by the Ad-Hoc Association and to provide further evidence that the Commission's power density limits are not correctly linked to the internal rate of absorption of radio frequency energy (e.g. specific absorption rate (SAR). As a result, the Commission's limits are too high by a factor of about 2.5. Thus, the Ad-Hoc Association has requested the Commission to reduce determine its power densities by dividing by 2.5 the present power densities the Commission applies to achieve a given average whole body SAR.

24.1 Findings: The Ad-Hoc Association FCC 96-326 Petition[145] and David Fichtenberg[146] showed that a 1992 study by O.P. Gandhi[142,143] showed that the average whole body SAR for an adult man was about 2.5 times greater than assumptions used in the late 1970's from which the Commission's limits were derived.[144]. A recent review indicated,

"Absorption under various exposure conditions was extensively investigated in numerous studies in the late 1970's. From these studies the current exposure limits for electric and magnetic field strengths have been derived." [Balzano, 1992[144]].

It was also shown that other studies found results consistent with an overestimation of about 2 fold by the assumptions used to derive the Commission's power density limits; these studies included those on both on human volunteers[147], and using computer simulations by Chen and Gandhi (1989) using the FDTD method for lower frequencies[148]. It was also shown in this proceeding[149] that dosimetric studies in 1984 also showed that for 450 MHz that assumptions linking power density to average body SAR were incorrect and would give a higher SAR than predicted by the assumptions used to derive the Commission's power density limits.

In this proceeding, it was shown that these 1970 studies determined the power densities for an adult man corresponding to a given average whole body rate SAR. It was also shown that the 1992 study of Gandhi found that these 1970 assumptions overestimated the power density associated with an average whole body SAR by a factor of about 2.5 needed to cause an average

whole body SAR was about 2.5 times greater t For an adult man the study was published in a peer-reviewed journal142, and in more detail for the Department of Defense, U.S. Army Medical Research and Materiel Command143

24.2 The questions for the Commission for giving weight to Gandhi's study[143,144] are:

- Was the researcher doing the study competent?
- Was the method used a valid method?
- Were the input parameters for any simulation reasonably valid?

The answers to these questions indicate the Commission should give much weight to the findings. Whenever there may be a number of reasonable approaches to setting limits, then the prudent course and that which bests protects the public health and public interest, is to find from among these various approaches, those that would lead to the most stringent SAR and power density limits, and then to select that approach. This is done not necessarily because one approach is "right" and the others "wrong". Rather, each approach may have certain strengths and weaknesses. However, once a reasonable number of scientists, or the Commission itself, finds an approach valid, then if it leads to being the approach leading to the most stringent limits, then these limits should nevertheless be adopted - for this is what prudence requires when there is continued uncertainty.

24.2.1 Concerning whether the researcher is competent, O.P.Gandhi was recently awarded the 1995 d'Arsonval Medal[150] of the Bioelectromagnetics Society for his leadership and accomplishments in this field, a listing of many of his key papers can be found in his address upon receiving this award.[150]. Dr. Gandhi served as co-chairman of the IEEE Standards Coordinating Committee 28 that developed the IEEE C95.1-1991 RF standard[83]; he was one of 11 members of the Committee On Assessment of the Possible Health Effects of Ground Wave Emergency Network[151]. Moreover, the Commission has explicitly stated,

"We agree with the commenting parties that the use of appropriate numerical and computational techniques, such as FDTD analysis, is acceptable for demonstrating compliance with SAR values. Studies by O.P. Gandhi and others indicate that such techniques offer valid means to determine energy absorption characteristics in exposed subjects."[152].

Therefore, the Commission must agree that Dr. Gandhi is competent to apply the FDTD method.

24.2.2 That the method is valid, please see above quote where the Commission recognizes explicitly the validity of the FDTD method. In addition, a recent 1997 review reports, "the finite-difference-time-domain (FDTD) method is much more popular," and continues to provide the reasons why this method has been found by many to be expected to provide reliable results[153]. Therefore, it is reasonable for the purposes of finding what might be the most stringent limits, to consider those limits obtained by applying this method.

24.2.3 That the input parameters the Dr. Gandhi used in this study may be considered reasonable is found from the following.

(i) These are the same parameters were used in an analysis which the ANSI/IEEE C95.1-1992 standard states provides *"an anatomically realistic model of a human being"*[154].

(ii) The paper which provides these parameters was among the papers directly referenced as B42, and used in developing the IEEE C95.1 standard[155].

(iii) These parameters were also among those used to develop estimates of induced foot-currents in a paper submitted for publication, and submitted to the Commission.[156]. Also, the Commission acknowledges that Dr. Gandhi "has done much of the research on induced currents and serves on the IEEE/SCC28 committee that developed the ANSI/IEEE guidelines.[157]"

24.3 That the entire approach is reasonable and worthwhile of consideration is supported by:

(i) It was published in the well-regard, peer-reviewed journal Health Physics142, the journal of the Health Physics Society.

(ii) The study was commissioned and supported by the U.S. Army Medical Research and Materiel Command, Fort Detrick, Frederick, Maryland. This indicates that the complete study elements of researcher, method, and input parameters was found appropriate for Department of Defense support.

24.4 Therefore, the Commission must agree that if this research indicates that the Commission's power density limits will result in a higher average whole body SAR then provided for in the basic protections asserted by the standard, that the Commission must adjust its power density limits. This is especially so, since much evidence has been given in this proceeding that the SAR 'safe' limits are also not sufficiently protective.

24.5 The simplest way to see that this study142,143 indicates the Commission's limits will be exceeded are by recognizing:

(i) For all body sizes there is a range of RF waves where the body optimally absorbs radio frequency (maximum average whole body SAR), and that for shorter waves, the average whole body SAR decreases until some limiting SAR is reached after which it is approximately constant[158], at least up to 6000 MHz, which is the upper frequency for which SAR is reported to be a meaningful measure[83].

(ii) For frequencies above 800 MHz through 6000 MHz, persons with smaller body sizes have higher rates of absorbing radio-frequency irradiation[158].

(iii) Dr. Gandhi's 1992 FDTD study of frequencies up to 915 MHz show that from above 350 MHz the average whole body SAR for an adult man is approximately constant, and equal to 0.08 W/kg.[142,143] when the exposure is 1 mW/sq. cm (1 milliwatt of power per square centimeter area)

(ivi) From above it follows that the expected average SAR for frequencies from 350 MHz through 6000 MHz will be 0.08 W/kg (e.g. stays constant) and thus in the Personal Communications Services range of 1850 to 1990 MHz will be 0.08W/kg for the average adult man when exposed to 1 mW/cm. sq.

(v) From (ii) above, it must necessarily be that infants exposed to PCS frequencies at a power density of 1 mW/sq. cm. will have a higher SAR than 0.08 W/kg which is for an adult man.

(vi) But an average whole body SAR = 0.08 W/kg is the basic protection which both the ANSI/IEEE 1992 and NCRP 1986 standard claim is assured when their power density limits are met.

(vi) Therefore, for frequencies above 1500 MHz, where the presently allowed limit is 1 mW/sq. cm., it necessarily follows based on Dr. Gandhi's findings that for body sizes smaller than an adult man that the average whole body SAR is expected to exceed 0.08 W/kg, which is not to be allowed according to the rationale upon which the FCC power density limits are derived.

24.6 Example: To see how much more the SAR may be, consider the estimates for average whole body SAR given in the references upon which the Commission's power density limits were derived. Consider only the orientation studied by Gandhi and exposures above 1500 MHz were

the Commission power density limit is 1 mW/sq. cm.. For 1900 MHz, in the center of the PCS frequencies, the SAR for an adult man had been assumed to be about 0.028 W/kg [page 6.4 of footnote 34] but based on the results of Gandhi can be expected to be 0.08 W/kg which is 2.8 fold higher (0.08/0.028) than previously assumed when the Commission's power density limits were determined. Also, the SAR of a 1 year old infant had been assumed to be 0.055 W/kg [page 6.10 of footnote 34], about 2 fold that of an adult man. Accordingly, it is reasonable to expect this relationship to still be approximately correct, so that at the Commission's limit of 1 mW/sq. cm. a 1 year old infant will absorb 2 fold of 0.08 W/kg, that is 0.16 W/kg which is 2 fold the maximum limit of 0.08 W/kg which the Commission standard should allow. Moreover, it can be expected that for even younger children, such as newborns, the SAR will even more greatly exceed the allowed limits.

24.7 Proposed study: Therefore, the Commission must request a study be made to determine power density limits that would assure not exceeding the Commission's 0.08 W/kg for even premature infants. These could be studies when lying down perpendicular to the path of the irradiation, called the "H" position, and which has been reported to be the position for absorbing the maximum SAR when the frequency is over about 1000 MHz. The Commission is encouraged to seek the counsel of the federal health agencies to whom the Commission has sought advice in this proceeding and to ask if it is reasonable for Dr. Gandhi to perform a similar SAR analysis for the PCS frequencies and for the very small body sizes as may occur for premature infants that are released to go home from the hospital, say being 5 pounds and 18 inches long. Insofar as Dr. Gandhi has already developed the means to do this analysis, one would expect the results could be provided reasonably quickly and at a modest cost.

24.7 Reflections off electrically reflective metal surfaces can further increase exposures:

As noted by the Ad-Hoc Association[159,160], Also, if such infants were placed where a metal filing cabinet, or aluminium siding of a house could reflect irradiation upon them, then exposures could even be 4 higher due to reflections from an electrically reflective flat surface, and 16 fold higher from electrically reflective corners[159], such as if an infant on the outside of a house with aluminum siding were placed in the corner of such a house facing a PCS transmitter. If the home

were on a hill and near a transmitter at a lower ground level height than the house, then the newborn infant may be in the path of the main beam.

25. Include rodent experiments when establishing hazard thresholds, especially when the exposure does not stress the animal by raising its body temperature.

Given present knowledge, considering only low level RF studies on non-human primates and not on rodents is not prudent, and applying results of rodent studies can be scientifically justified

25.1 Present hazard thresholds are based only on a few limited studies of non-human primates Both the RF health and safety standards of NCRP 1986 [at page 279 of footnote 161] indicate that the thresholds of disruption of behavior in non-human primates is above 3 to 4 W/kg, *"the latter of which was taken as the working threshold for untoward effects in human beings in the frequency range from 3 MHz to 100 GHz."* The 1992 ANSI/IEEE RF standard states similarly [section 6.3 of footnote 83]. Both refer to at most the same 4 experiments completed by 1984 on either squirrel monkeys or rhesus monkeys.

25.2 Many more studies of disruption of behavior have done on rodents than non-human primates, so by the greater number of studies examining different kinds of behavior disruption, it becomes more likely to discover if there are thresholds at lower levels for certain kinds of behavior disruption. For example see the papers reviewed for preparing the 1992 ANSI/IEEE RF standard[83].

25.3 There are a number of studies of rodents at exposure conditions at which there was no observed increase in body temperature. One reason justifying considering only non-human primates, is that their thermoregulatory system is closer to that of humans, and is more efficient that those of rodents, who when exposed to the same external power may have more difficulty dissipating the heat than a non-human primate.

However, if studies are considered where there was no evidence of increased body heating in the rodent or other signs of stress, then it would be reasonable to include these studies. For such studies the average whole body SAR has been as low as 18% or even lower from the Commission hazard threshold.

25.4 Agencies and researches knowledgeable about RF effects have found rodents to be justifiable models to use to estimate effects on humans.

25.4.1 Department of Defense finds rodent models may predict adverse human effects

Funding was provided by the Department of Defense for a University of Washington study exposing rats for up to 25 months to RF at 10% of the Commission's hazard threshold, 0.4 W/kg, which is the level deemed 'safe' for the occupational/controlled limits of the Commission.

Concerning this study, the authors report,

"The goal of the project was to investigate effects on health of long-term exposure to low-level, pulsed microwave radiation....Although the initial impetus for the study was the question of environmental impact of the Air Force PAVE PAWS system, early on it was decided not to study a replica of the PAVE PAWS emissions, but to create a generalized level of radiation that would provided whole-body exposure based on the maximum of permissible exposure.[162]"

Thus, it is seen the Department of Defense saw the use of rodents as suitable for an environmental impact study of a radar system on the health of humans; the study included measures of disruption of behavior indicating that what may occur to rodents is relevant to environmental impacts on humans.

25.4.2 The National Institute of Environmental Health Sciences (NIEHS) funded a University of Washington study on the RF exposure effects on the memory of rats. Rats were exposed to only 15% of the Commission's hazard threshold. In the introduction to the study it was reported,

"Study of the spatial memory functions in rodents has been suggested as a model for the investigation of cognitive and memory functions in humans. Deficit in memory functions, even transient, can lead to serious detrimental consequences. Thus, it is important to understand further this behavioral effects of microwaves and, especially, the underlying neural mechanisms involved.[163]"

It is of interest to note that two of the three the co-authors of this study included two members[164] of the IEEE RF health and safety committee which developed the RF standard IEEE C95.1-1991, and included the chairman of the NCRP 1986 RF criteria report, and Vice Chairman of the balloting committee that approved the 1991 IEEE RF health and safety[164]. Thus, it can be assumed that experts knowledgeable in RF concluded that their findings of the effects of RF on the memory of rodents was relevant to impacts of RF on humans.

25.5 Prudence, caution, and due diligence in the present state of much uncertainty justify assuming RF effects found for rodents should be assumed to apply to humans until shown otherwise.

25.6 It is important to include rodent studies because it is among these studies that adverse effects have been found at RF exposure levels much lower than among the 4 studies on non-human primates noted above. Thus, excluding rodent studies, has the effect of excluding the vary studies which have been found to demonstrate adverse effects of RF at levels far below those exposure levels for the up to 4 non-human primate studies noted by NCRP 1986[161] and IEEE 1991[83].

The Ad-Hoc Association has noted in this proceeding that there are 4 rodent studies showing disruption of learned behavior or learning of new behavior at levels 15% to 18% of the Commission hazard threshold[165], of which one was among the papers found suitable by the IEEE RF 1991 committee for setting RF standards[166]. Also it was noted that there were a total of at least 6 to 7 studies found suitable for standard setting and reporting disruption of behavior at average whole body SARs 60% to 5% of the Commission's hazard threshold[166]; these 7 studies were among the papers found suitable by IEEE committees for setting the 1991 IEEE RF standard[83,166].

Therefore, it is very important to consider rodent studies when deciding upon a hazard threshold, for otherwise, those studies showing adverse affects at very low SAR levels will be excluded, and the public health may be seriously compromised.

25.7 The studies referenced in item #25.6 above demonstrate that the rationale for NCRP 1986 and ANSI/IEEE C95.1-1991 RF exposure criteria is problematic. This is because both of these standards assert the threshold for disruption of operant behavior of rodents reported in the scientific literature is above 3 W/kg, yet both of these standards reference studies reporting disruption of operant behavior at levels, and with at least one study reporting effects for exposures as low as 0.2 W/kg.

25.7.1 ANSI/IEEE C95.1-1991 states,

"The disruption of a highly demanding operant task is a statistically reliable endpoint that is associated with a whole-body SARs in a narrow range between 3.2 and 8.4 W/kg, despite

considerable differences in carrier frequency (400 MHz to 5.8 MHz), species (rodents to rhesus monkeys), and exposure parameters..." [section 6.4 of footnote 83].

Yet, as referenced in #25.6 above, 6 studies in the list of papers ANSI/IEEE C95.1-1991 reported as suitable for standard setting and reviewed for preparing this standard reported disruptions of behavior below 3.2 W/kg, and including disruptions at 2.3, 2.0, 1.6, 1.2, 0.7 and 0.2 W/kg [listed in order as in Ad-Hoc Association FCC 96-326 Petition pages 10,11, 14.3.1-14.3.6]. Thus, this standard lists papers showing effects below 3.2 W/kg, but then claims that no such effects were observed - thus being internally inconsistent.

In 1993 the EPA told the Commission that the ANSI/IEEE C95.1-1991 standard, *"lacks explanation, consistency, and well-founded justifications."*[page 1 of Comments of footnote 167]. Perhaps the inconsistency noted in the above paragraph is one of those considered by EPA.

Likewise, the FDA wrote in its Nov. 10, 1993 letter to the Commission that, "In our opinion, it is unclear what types of biological effects and exposure conditions are addressed by the standard.[135]" Perhaps the FDA also had in mind the studies noted above, since this standard claims to use 'disruption of behavior' as the basis for selecting its SAR hazard threshold, but then picks a SAR threshold below which are SARs associated with many studies reporting disruptions of behavior; so its not clear how the biological effect of 'disruption of behavior' is addressed by this standard.

25.7.2 Likewise NCRP 1986 makes a similar claim as IEEE C95.1-1991 and states,

"The carrier frequencies associated with behavioral disruption range from 400 MHz to 5.8 MHz. These studies were performed on species ranging from laboratory rats to rhesus monkeys, and involved near-field, far field, multipath, and plane wave fields, both continuous wave and modulated. In spite of marked differences in field parameters, thresholds of behavioral impairment were found within a relatively narrow range of whole-body-averaged SARs ranging from ~3 to ~9 W/kg."[page 279 of footnote 161].

When the list of papers on disruption of operant behavior was reviewed by NCRP, there were 3 papers in the section "Long-term Exposure" - a considerable concern of the public. Only 3 papers were reviewed in this section:

- Moe et al (1979) which exposed rats to 4 to 7.5 W/kg for 3 weeks;
- Mitchell et al.(1977) who exposed rats to 2.3 W/kg for 22 weeks;
- D'Andrea et al (1979) who exposed rats to 1.23 W/kg for 16 weeks.

The two studies for which the exposure was at least 16 weeks both found disruption of behavior. Also, two unreplicated studies of RF drug interactions found effects at a whole body-average SAR of 0.2 W/kg (Thomas and Maitland, 1979 using dextroamphetamine; and Thomas et al. using chlordiazepoxide, 1979). Therefore it is unclear on what basis NCRP 1986 asserts that in the science-based literature that the thresholds reported are from ~3 to ~9 W/kg - since 4 of the above studies reported by NCRP 1986 show otherwise[167,168]. [for further references, please see full references in NCRP 1986]

25.7.3 Therefore, claims by NCRP 1986 and ANSI/IEEE C95.1-1991 that its limits are based on a hazard threshold that is associated with the lower limit for disruption of behavior among rodents is problematic, and appears inconsistent with studies which NCRP documents. Accordingly, claims by these standards that their hazard threshold applies to rodents should be questioned by the Commission, and the Commission should ask the federal health agencies to verify the claims herein by the Ad-Hoc Association.

26. Further evidence that there is not a consensus that the Commission's limits are safe are the limits recommended by Dr. O.P. Gandhi, a recognized expert in the field of bioelectromagnetics (see #24.2.1 above) and co-chairman of the committee that developed the RF IEEE 1991 standard. Dr. Gandhi has repeatedly in 1986[169], 1988[170] and 1990[171] proposed limits which are 25% to 30% of that proposed by NCRP 1986 and by IEEE C95.1-1991 for cellular phone and PCS frequencies respectively.

Dr. Gandhi's proposal's include::

Frequency in MHz	Electric field Volts/meter	Square of electric field (Volts/meter)2	Power density[172] microwatts/sq. cm. Gandhi	Commission NCRP 1986
30-100	8	64	17	200
100-5900	$0.8 \times f^{1/2}$	0.64 f	17-1000	200-1000
Examples				
900 MHz	.8 x30 =24	576	153	600
1900 MHz	.8 x 43.6=35	1216	323	1000

Thus, it is seen that there is not a consensus concerning the limits selected by the Commission, that rather there are experts, such as Dr. Gandhi who believe the Commission limits should be considerable lower. The Commission is urged to ask Dr. Gandhi what protections he believes his limits would provide, and may not provide, e.g. would exceed protection limits determined by applying a safety factor of 50 to 100 to exposures at which adverse effects have occurred and including those documented in this proceeding.

27. Other evidence supporting the claims of the Ad-Hoc Association that the Commission's limits should be no more than 18% of the 4 W/kg present hazard threshold is the review by D'Andrea and de Lorge noted by the Ad-Hoc Association in this proceeding[173b]. These two researchers from the Department of the Navy[173a,173b3] who were also members of the RF 1991 IEEE committee83, and co-authors of the studies on non-human primates that were selected as the basis of the SAR hazard threshold by IEEE[83]. These researchers conclude, *"Based on the results of these studies, it is possible to specify that a threshold for significant behavioral effects at 2450 MHz is between 0.4 and 0.7 W/kg*[173b]." [note: these authors did not consider some of the studies noted by the Ad-Hoc Association which would even justify lower than 0.4 W/kg as a threshold, especially when drug interactions are considered.]. Thus, they support the Ad-Hoc Association finding that based only on studies of disruption of operant behavior that the hazard threshold should be no greater than 0.6 to 0.7 W/kg, and not 4 W/kg as the Commission has selected.

28. Partial body exposure criteria of NCRP is needed to protect workers at Commission licensed facilities

28.1 The problem: To protect workers constructing, maintaining, and repairing transmitters at Commission licensed facilities the Commission did not do as it was advised by the EPA, NIOSH, and OSHA. and as it said it would do. The Commission has been requested [Ad-Hoc Association FCC 96-326 Petition at page 13, item 14.9] not to use the ANSI/IEEE C95.1-1992 partial body power density limits, but rather to rely upon the basic protection limits in terms of local body SAR limits. The Ad-Hoc Association wishes to make it clear that the Commission must explicitly state in its rules, that the local body SAR provisions of NCRP 1986 Section 17.4.6 applies to all local body areas and from whatever source, e.g. from Commission licensed hand-held portable phones,

or from near field exposure to base station transmitters while communication workers may be constructing, maintaining, or repairing such transmitters.

Specifically, the Commission has made no provision in its exposure criteria for protecting workers who may receive high local body exposures when constructing, maintaining, or repairing transmitters for Commission licensed facilities. Rather, the Commission has provided a set of power density limits and associated SAR of 0.4 W/kg and 0.08 W/kg for whole body exposure of workers who meet the occupational/controlled criteria, and for the general population/uncontrolled criteria respectively. Also, the Commission has applied the limits for local body exposure in terms of specific absorption rate (SAR) of radiofrequency energy for "certain portable transmitting devices" and for these has adopted the Section 17.4.6 of NCRP 1986. However, the Commission only applies these partial body protections in terms of SAR partial body limits for the case of "portable" transmitting devices, but not for "fixed base station" transmitting devices.

As a result, the face or other body part of a communication worker or an electrician who may be constructing, maintaining, or repairing a transmitter of a Commission licensed facility may be very close to a transmitter emitting irradiation. Then his face, neck, chest, or other body part may receive more that permitted for portable transmitters. But because these transmitters would be base stations and not portable, then these workers would not be protected, since there total whole body average would most likely still meet the whole body exposure limit provisions.

To correct this oversight, the Commission must add to its rules provisions in accordance with EPA, NIOSH, OSHA, and well as those noted in this proceeding and herein by the Ad-Hoc Association. Consider the following:

28.2 The federal health agencies have recommended that localized body protections from high SAR be provided for workers, regardless of whether the Commission licensed transmitter is portable or not portable.

28.2.1 EPA has recommended to the Commission that the NCRP criteria be adopted; EPA never said that the localized SAR provisions in Section 17.4.5 should only apply to portable transmitters

but not to other RF sources; but yet the Commission is only applying Section 17.4.5 to the case of portable transmitters.

28.2.2. NIOSH specifically told the Commission:

"Evaluating exposure of workers within a few feet of a transmitting antenna must include determinations of SAR as well as induced and contact current in the body." [comment on page 3 of footnote 139, and reaffirmed at footnote 174]

28.2.3 OSHA has stated for workers to be in an environment where the external exposures are higher than allowed for the general population, that a traditional RF health and safety program should be in place *"to mitigate any potential increase in risk."*[139] Clearly, any reasonable RF health and safety program would seek to assure there is not excess localized body exposure.

Moreover, in its August 1997[175] comments to the Commission, OSHA stated that it understood the Commission was considering guidelines which include *"adoption of ANSI/IEEE limits for localized specific absorption rate"* - i.e. for all parts of the body and for all sources, and not just for the head from portable phones.

28.2.4 Thus, EPA, OSHA, and NIOSH have indicated that the SAR limits for localized body exposure should be included in the Commission's rules. And OSHA has clearly specified that protection be provided (e.g. thorough clothing, engineering controls, etc.) so that the RF program is *"designed to mitigate any potential increase in risk."*

28.3. Moreover, the Ad-Hoc Association has provided evidence herein that there is not sufficient scientific basis to expose the heads of workers more than the general public, as now in the Commission's adopted rules.[see above item #2.9.1 and #2.9.2, and that the exposure criteria should be more stringent - see elsewhere in the submission.]

28.4 The Commission's SAR and power density exposure criteria need to provide for the multiple sources of exposure that electrical or communications workers may receive when they are constructing, maintaining, or repairing a transmitter or receiving antennae, and there are near by co-located transmitters of the same or different operator, and it needs to be specified in the RF health and safety program how workers will be protected so as to *"mitigate any potential increase in risk*[139]."

28.5 Speculation on why it is important to keep localized SAR "as low as reasonably achievable."

To help motivate the Commission to implement the above changes, consider the study of Huand and Mold of the Division of Hematology and Oncology in the Department of Medicine of Duke University Medical Center[180]. They observed immunologic and hematopoietic changes and commented,

"Bone marrow cells are one of the most actively proliferating tissues in vertebrates and are usually more sensitive to changes in the environment. Furthermore, the marrow space is mostly cylindrical (long bones, spine, and ribs) or is enclosed between plats of bone (sternum, skull, and pelvis), and may differentially absorb higher energy from microwave radiation." It is also noted that the effect of such bony plates or casing can increase heating in the bone marrow 3 ways:

(i) The low water content plates or cylinders allow more RF energy to penetrate the bone;

(ii) The blood vessels the blood vessels passing through the bone are very narrow, thus circulation in bone marrow is poor and heat dissipation may not be as effective, with thicker bones of humans being more effective in keeping blood flow slow, since the narrow channels are longer for thicker bones,

(iii) The low water content bone may act as an insulator, helping to keep trapped heat in the marrow.

The above speculation may provide a rationale why leukemia or blood abnormalities have been found to be associated with higher RF exposure.[181].

These speculations may serve to motivate the Commission to help assure localized body exposures of workers servicing transmitters is kept as low as reasonably achievable.

29. Modify "§1.1307 to account for seemingly separate transmitters on different towers or on different roof-tops, but which are near the same height and close enough to the upper floors homes, schools, hospitals, parks, or workplaces such that their combined exposure causes an out-of-compliance condition, as requested by the Ad-Hoc Association[177]. This modification is needed because the Commission's rules now specify, *"total power of all channels ...means the sum of the ERP or EIRP of all co-located simultaneously operating transmitters of the facility.*[176]" The Ad-Hoc Association has suggested the very cautious approach of defining 'facility' as all the

transmitters within a given distance from occupied areas subject to exposure [see footnote 177 for details].

30. The Commission rules are presently inconsistent regarding exposure of persons who are not in control of their exposure. In 47 CFR §1.1310, the Note 2 to Table 1 provides that for any persons who are not in control of their exposure, that the 'general population/uncontrolled' tier exposures apply. Indeed, this is what the Ad-Hoc Association wants, and is consistent with the principles 17.4.3 concerning the general population.

However, the Note 1 to Table 1 allows that persons who are not in control of their exposure may, in special circumstances, be subject to the 'occupational/controlled' tier of exposures. This is inconsistent. See above items #13.0 to 13.4.4. on what corrections need to be made.

31. Possible mechanisms of interaction for very low power exposures:

If the Commission wonders, how can it possibly be that the very low exposures from its base stations can have adverse affects, then consider the following possibility.

31.1 Brain EEG affected: When people sleep, their body systems change dramatically. If in some way RF simulates the brain while people sleep, so that part of the brain 'wakes up' from deep sleep, and does not sleep as usual, then, without causing an 'direct damage' ,the RF perhaps could stimulate the neuroendocrine system, and thus change circadian rhythms, and thereby, body function. Perhaps even stimulation during the day to parts of the brain not typically so stimulated will affect the neuroendocrine system.

In terms of feasibility, it has been reported that brain EEG patterns change at SARs as low as 0.0001 W/kg[179], 1/40,000th of the Commission's hazard threshold of 4 W/kg.. Could such EEG stimulation (i) affect the neuroendocrine system rhythms, (ii) stimulate cell apoptosis, or (iii) signal brain microglial cells to react in 'attack' mode and produce neurotoxins, which they are known to do? [see item #2.11 above].

31.2 Calcium ion balance in brain tissue is affected by RF exposures amplitude modulated at 16 Hz in the range of 0.0013 W/kg to as low as 0.0006 W/kg. This is below 1/2,000th of the Commission's hazard threshold of 4 W/kg. This is important because EPA says,

"calcium ions have a prominent role in many biochemical and biophysical processes (e.g. cellular membrane integrity and function, enzyme cofactor, putative second messenger for the conduction of extracellular signals to the nucleus of the cell, neural tissue excitation and secretion of transmitter substances at synapses."[page 5-88 at footnote 15]

EPA has also noted that the observed calcium ion efflux effects in cell-cultures has been repeatedly found and by independent investigators [see studies on pages 5-88 to 5-93]. It is interesting to note that studies which have not this calcium efflux effect have tended to be pulse modulated and not amplitude modulated, resulting in a consistent finding for amplitude modulation [see studies on pages 5-88 to 5-93, and EPA comments on studies of Merrit (1982) discussed on these pages].

Recent studies have discussed links between adverse health conditions and calcium ion imbalance. An epidemiology study by E. Sobel which found a 3 fold greater risk for Alzheimer's Disease in person's exposed to high ELF frequencies reported,

"There are substantive reasons to suspect that electromagnetic fields may play a role in the etiology of Alzheimer's disease. Calcium ions may play an important role in the development of Alzheimer's disease. An inability of neurons to maintain calcium ion homeostasis can lead to cell death."[210].

Likewise, it has been reported, *"Measurements of calcium [Ca^{2+}], using the calcium indicator dye fura-2 demonstrated a direct relationship between increased , and neuronal degeneration."*[211].

Also, it has been reported, *"Collectively, the data suggest a possible role for calcium ion (Ca^{2+}) in the process of skin tumor promotion by anthrones."*[212].

Finally, it has been reported in 1997 that,

"The biologic plausibility of EMF as a possible etiologic factor in the development of amyotrophic lateral sclerosis (ALS) is strengthened by 1) the recent findings of calcium ion channel antibodies to motor neurons in sera of sporadic ALS cases; 2) the increased intracellular calcium ion Ca2+ in motor neurons exposed to ALS IgG; 3) the vulnerability of the motor neurons to increased intracellular Ca2+; and 4) the research over the past decade indicating that EMF exposure may be able to inappropriately activate the immune system in EMF exposed subjects."[213].

31.3 Possible direct stimulation of endocrine system.

31.3.1 Hot spots in head: Consider that many of the telecommunications services are in the frequency range of 300 MHz to 2000 MHz and that this is considered the range where RF energy

'hot spots' can occur in the human head.[199,200], with near 915 MHz the frequency at which such hot spots can be at a maximum, as, Johnson and Guy (1972) report,

*"The peak internal heating for the human head size sphere is maximum in the UHF frequency range centered near 915 MHz. This again is significant in terms of the large number of reported central nervous system effects for human exposure in the UHF frequency range.*178."

31.3.2 Melatonin may be affected: Many endocrine glands are in the head including the pineal gland that makes the hormone melatonin, that helps induce sleep. Melatonin has been associated with blocking or slowing down the rate of growth of certain tumor cells[182,183,184], and whose production during the night has been sharply reduced upon exposure to visible light as well as non-visible electromagnetic fields[185,186]. Epidemiology studies are beginning to find a link between certain cancers or job classifications and melatonin[186,187,188]. Indeed, in a recent review of epidemiologic methods for studying cancer, the only biological hypothesis offered was the 'melatonin' hypothesis drawing upon the evidence linking melatonin to tumor suppression and to EMF effects blocking directly blocking that suppression as well as block melatonin production.[187].

31.3.3 RF effects often reflect ELF effects, so there is cause to speculate RF can affect melatonin While the above results pertain to studies of power line frequencies, there are studies which find similar or related effects for RF when the carrier signal is pulsed or amplitude modulated at an ELF frequency[197], and that this is an especial concern with the advent of digital telecommunications[197]. Indeed, a report by the U.S. General Accounting Office found,

"Some researchers have suggested that digital transmission signals, under certain circumstances, may be more likely to produce nonthermal effects with consequences for human health than analog signals."[198].

Thus some researchers suggest that ELF effects should guide in selecting studies of RF when searching for possible effects. Therefore, there is a relevancy of the above studies when speculating what affects RF may have on melatonin production. For example,

at a 1993 EPA Radiofrequency radiation conference, it was reported,

"One panelist described the difference between the internal fields from "direct" ELF (e.g. from power lines) and fields generated from RF radiation, where the latter fields are much greater (by as much as 100,000 times). Thus, the panelist noted, the internal ELF fields from ELF-modulated RF radiation may be more significant than from direct ELF. Another panelist commented that effects due to ELF-modulated RF radiation that are similar to direct ELF fields have been observed experimentally, although the results have not been conclusive." [pg. 15, 16 at footnote 10].